Improving of the temperature monitoring system in INCDTIM Data Center

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Outline

1. INCDTIM Data Center – past and present status:
   - Computing system development
   - Network capabilities
   - Backup capabilities

2. Monitoring of Data Center Parameters – temperature (previous and new system)

3. Temperature variation in Data Center - Previous monitoring system with 4 sensors
   - New monitoring system with 12 sensors

4. Conclusions

INCDTIM Datacenter – previous status

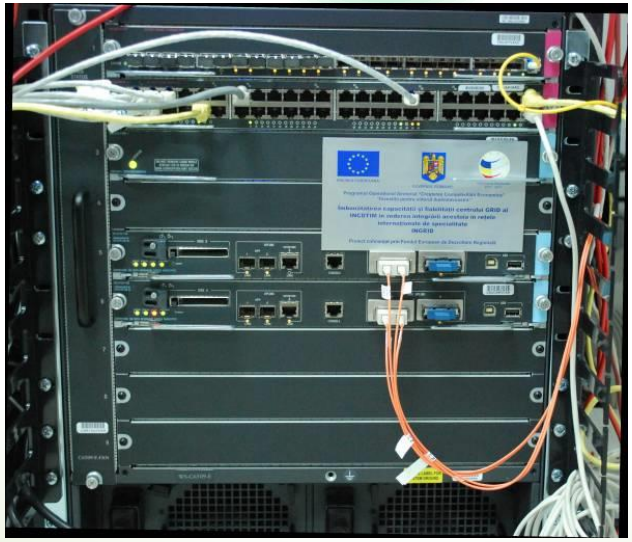
- Grid site **RO-14-ITIM**
  - **400 Core-s (1U servers + Blade systems), dedicated 100 TB storage system**
- **MPI Cluster**
  - **512 Core-s (16 Core, 96 GB RAM, 450 GB HDD / Computing unit)**
- **Network infrastructure of the Institute**
  - **Applications servers (e-mail, web, ftp, databases)**
  - **Core network and distribution switch system**

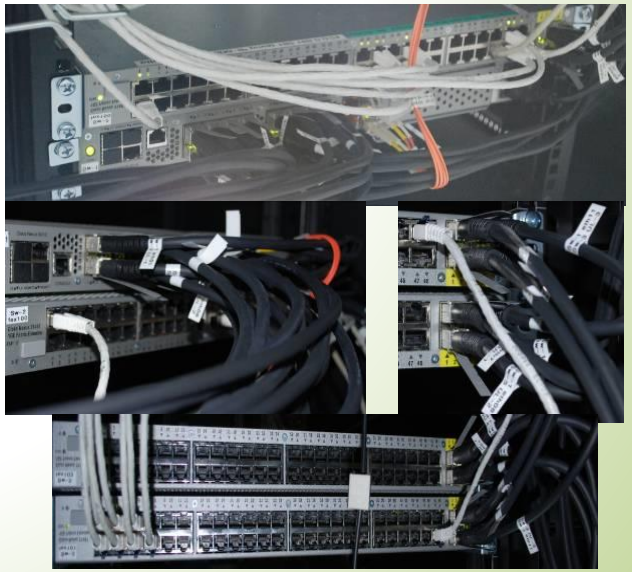
INCDTIM Datacenter – present status

- Grid site **RO-14-ITIM**
  - **600 Cores, mix different technologies (1U servers, Blade systems (IBM & HP)**
- **MPI Clusters**
  - **512 Cores - 32 nodes (16 Core, 64 GB RAM, 250 GB HDD each)**
  - **128 Cores - 4 nodes (32 Core, 64 GB RAM, 200 GB SSD each)**
  - **80 Cores - 1 node (80 Core, 384 GB RAM, 2+ TB SSD+HDD)**
- **Multiple standalone computing units (20 – 32 Cores, min. 64 GB RAM, 1+ TB SSD+HDD)**
- **Network infrastructure of the Institute**
  - **Applications servers (e-mail, web, ftp, databases, users files)**
  - **Storage system with minimum 16 TB capacity**
  - **Core network and distribution switch system**

Network capabilities

- **Layer 3 Core Switch - Cisco 6509E**
  - **10 Gbps** uplink to Romanian Education Network starting from 1 Feb. 2011
- Nexus switching system
  - **40 Gbps** inside the Grid site
  - **20 Gbps** between Grid Site and Core Switch





Backup capabilities

- **UPS 96 kVA**, maximum load was **65 kW** for the entire Data Center
- **Diesel powered energy generator** for emergency situation (power failures)
  - starts in **8 seconds;**
  - can function up to **8 hours.**
- Monitoring system of **temperature, humidity** and **fire**
- Backup Network link up to **300 MBps**

Power generator 275kW

Important parameters for optimum working of Data Center

- *Air conditioning*
- *Temperature*
- *Humidity*

Why temperature monitoring?

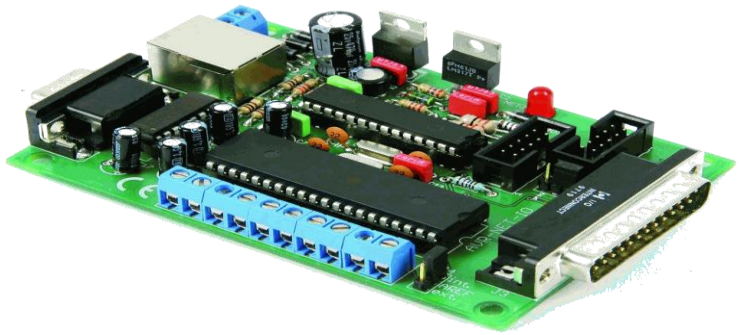
- the temperature is an important parameter for the equipment functioning
- the computing systems are designed to work best when the ambient temperature is in the range 20 – 23°C
- constant temperature → air conditioning systems → high quantity of electricity
- to minimize energy consumption

Monitoring of Data Center Parameters

Previous system

A microcontroller-based module designed and built in INCDTIM provide information about:

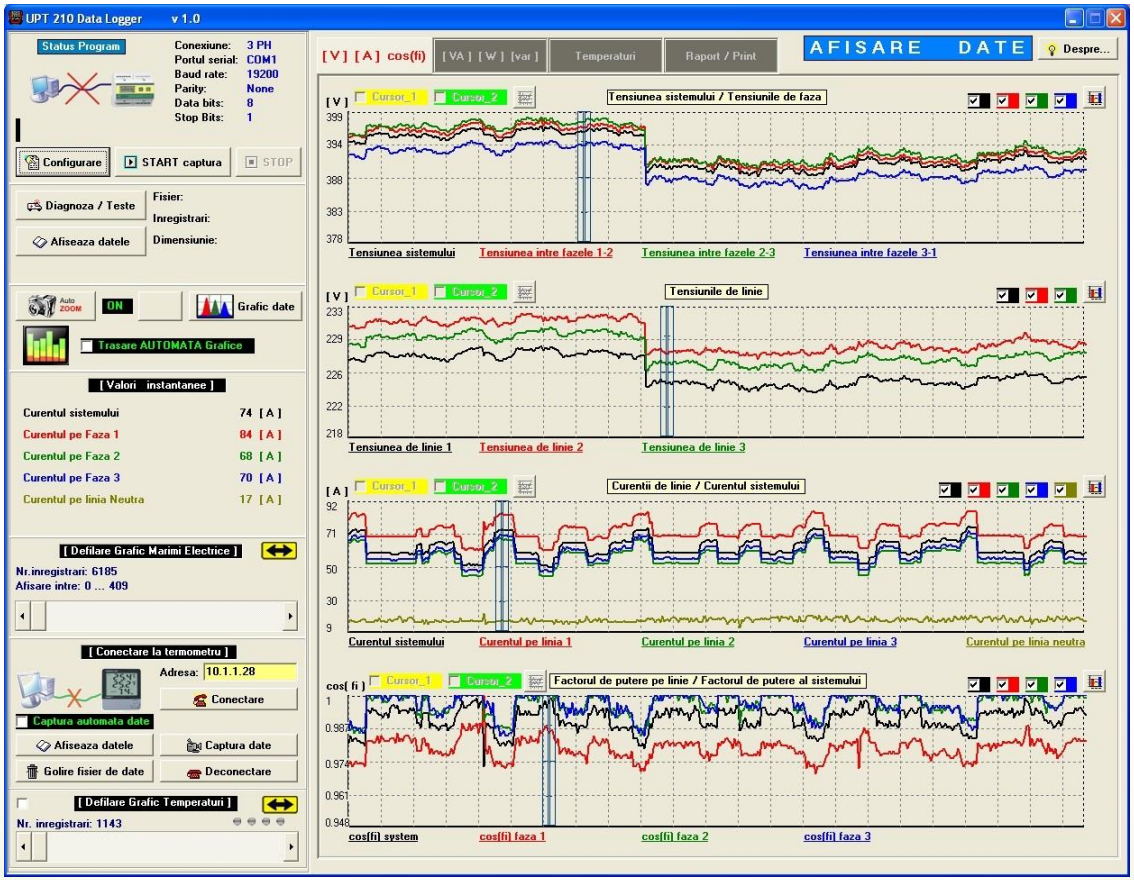
- temperatures (T1 - GRID site rack 3, T2 - HPC cluster rack 9-10, T3 - heat agent temperature, T4 - outside ambient temperature);
- voltage power supply of the cooling units;
- functioning of the condenser fans;
- temperature of the cooling agent from heat exchange circuit.



Microcontroller-based module - measures temperatures and monitor the state of the air conditioning (AC) units

Monitoring of Data Center Parameters

Previous system

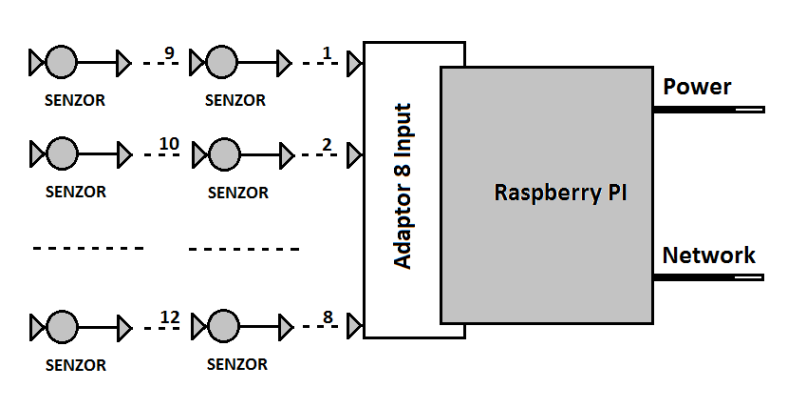


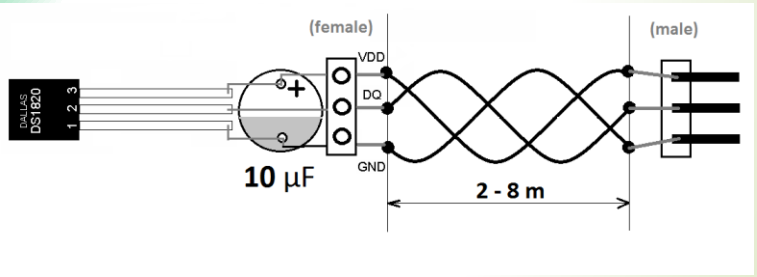
Graphic interface of the “Data Logger UPT210” application and for “Cooling system monitor”

Monitoring of Data Center Parameters

NEW system

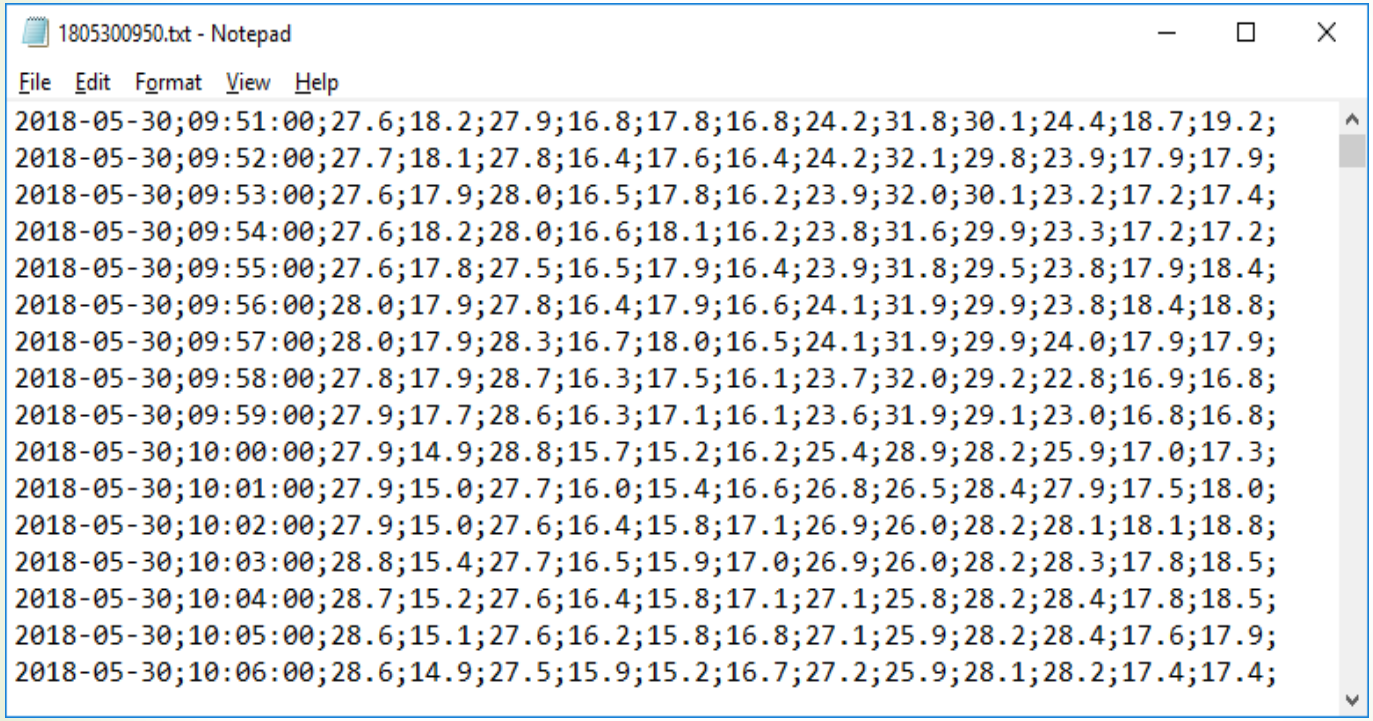
•A Raspberry Pi microcomputer system that connect 12 new **1wire type** temperature sensors placed inside the Datacenter;
•Sensor connection schema and the software application that's collect data provide by sensors was developed in INCDTIM;





NEW system

• The monitoring system allows up to 256 sensors to be connected, the data provided by them are stored in the data files, with the bellow structure.

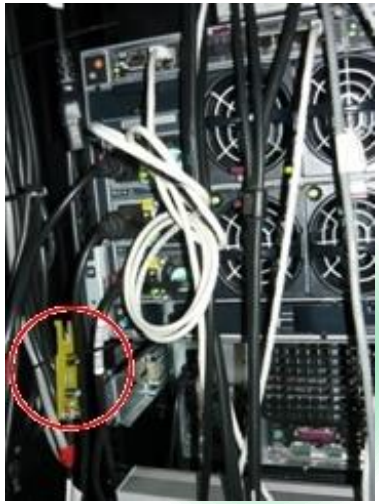


Data file structure/output for 12 sensors

Old system

Place of temperature sensors in Data Center

Temperature sensor on cooling agent pipe of air conditioning system

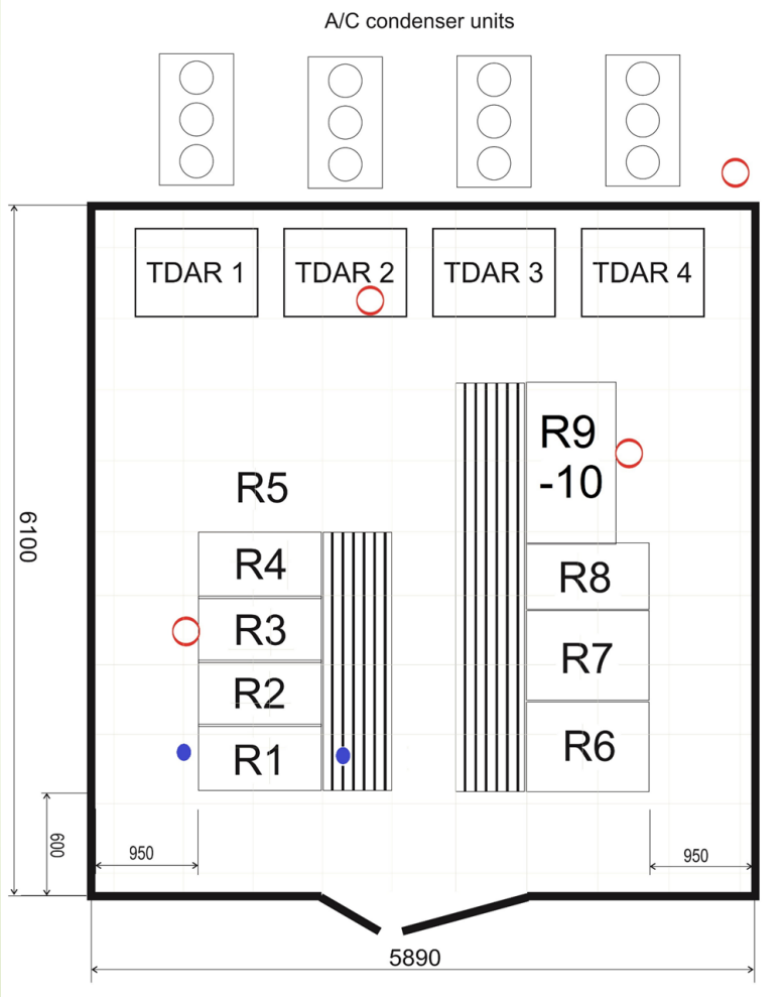


Temperature sensor in hot areas inside the servers rack

The temperature sensor for the environment outside of the cooling system

Temperature sensors position

OLD / NEW position

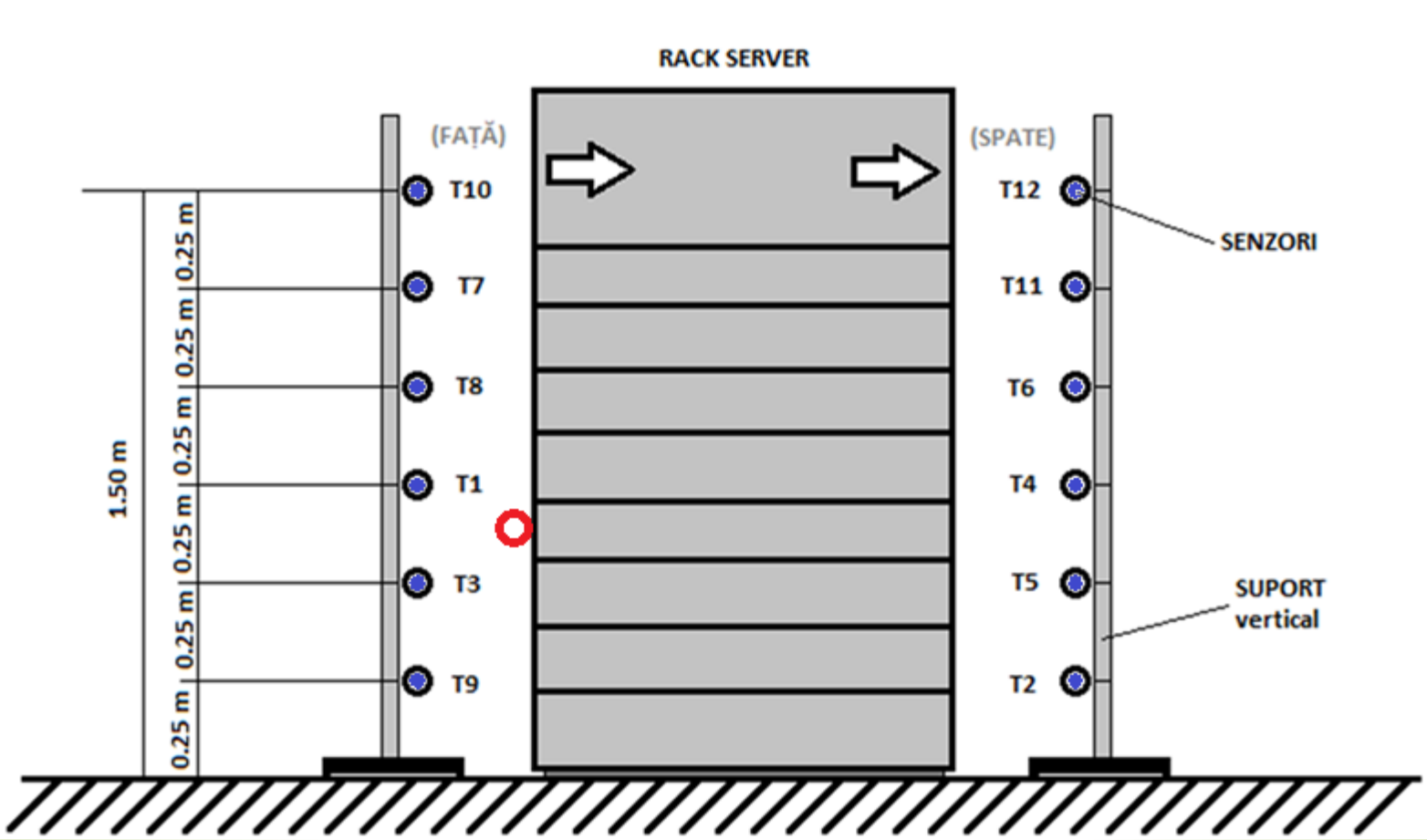


R1-R8 - 600 x 1070 racks
R3 - GRID site rack
R9 - HPC cluster rack
○ - position of the 4 sensors
▯ - ventilation grids
● - position of the new 12 sensors

Schema of Data Center

Temperature sensors position

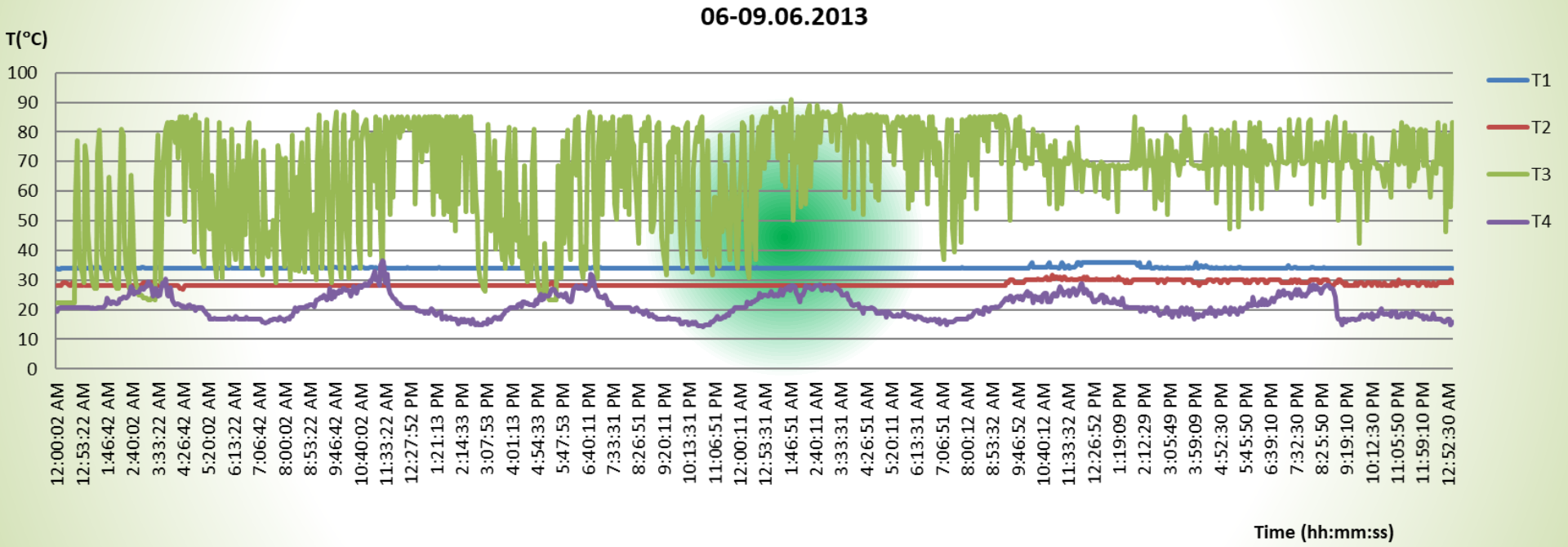
OLD / NEW position



Sensors position in high

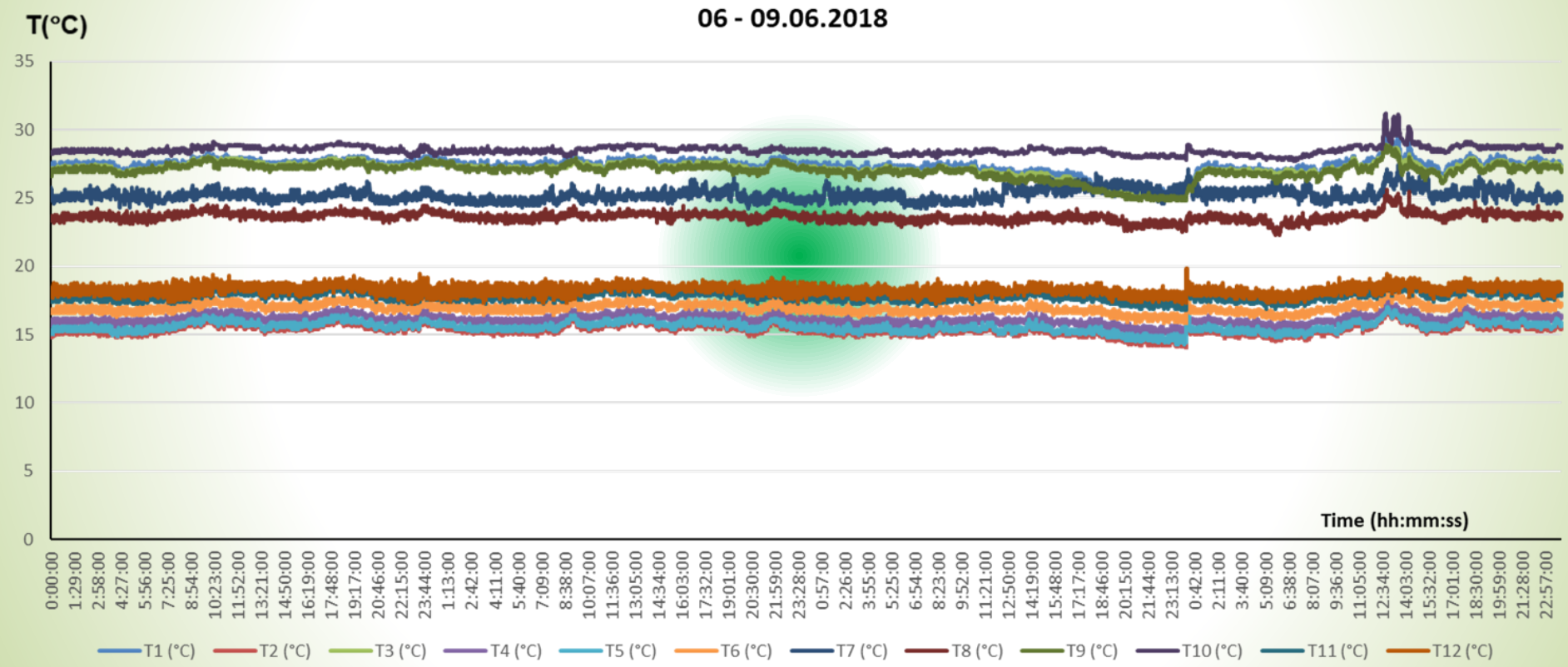
Temperature variation in Data Center

Previous monitoring system with 4 sensors

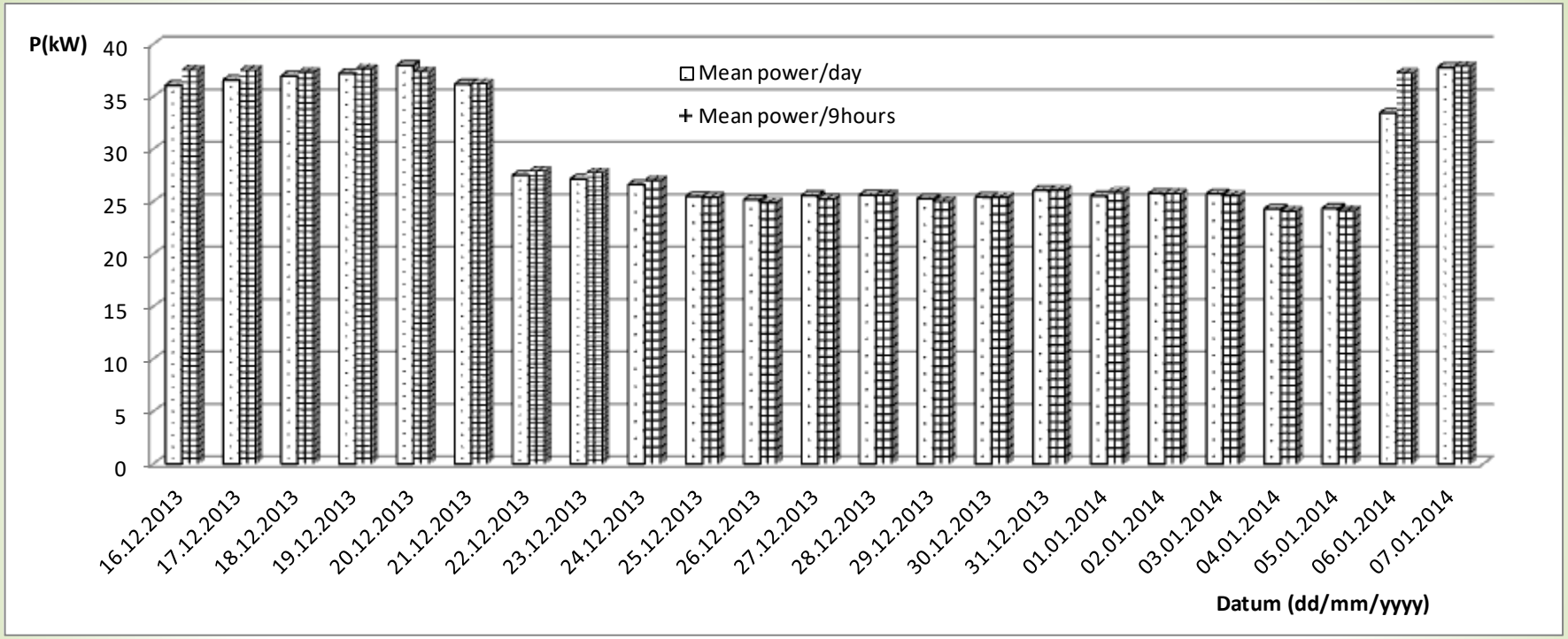


Temperature variation in Data Center

NEW monitoring system with 12 sensors

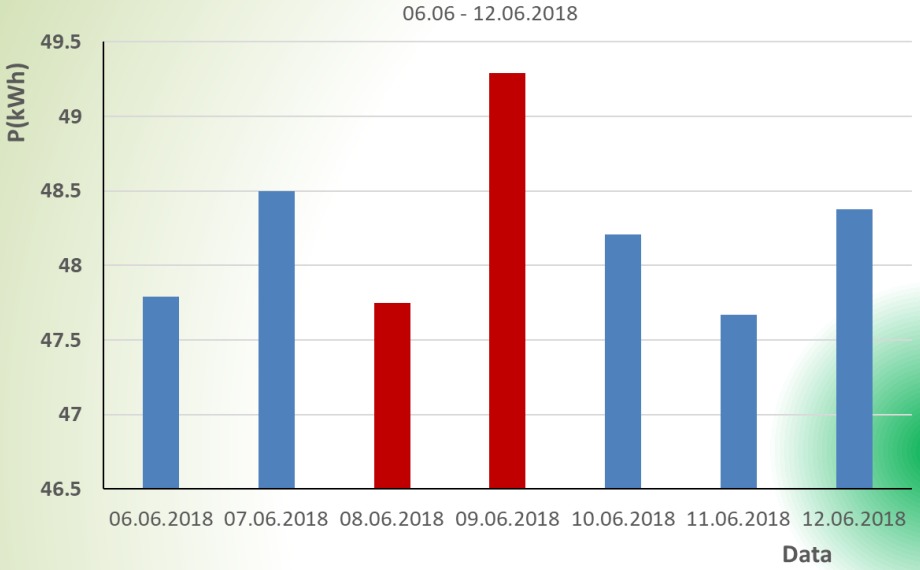


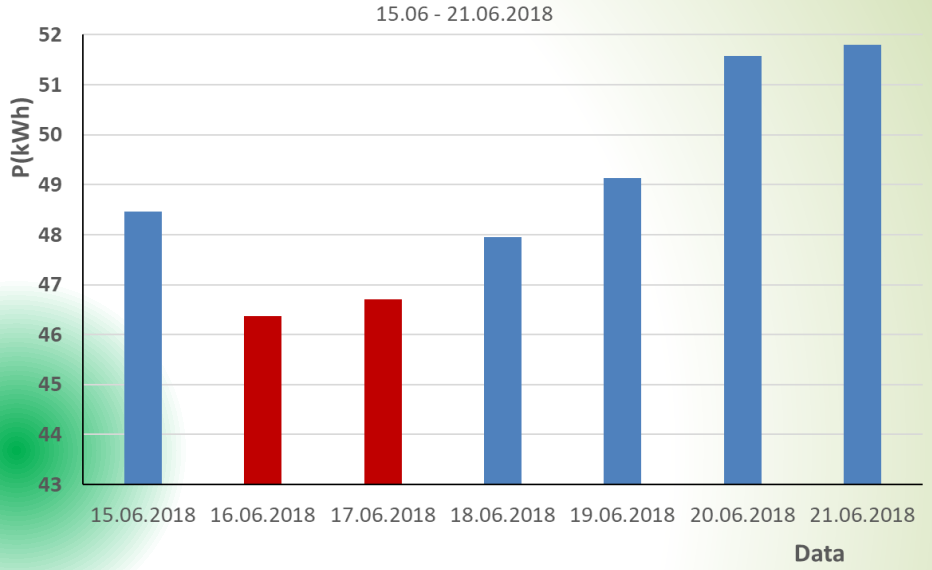
Power consumption

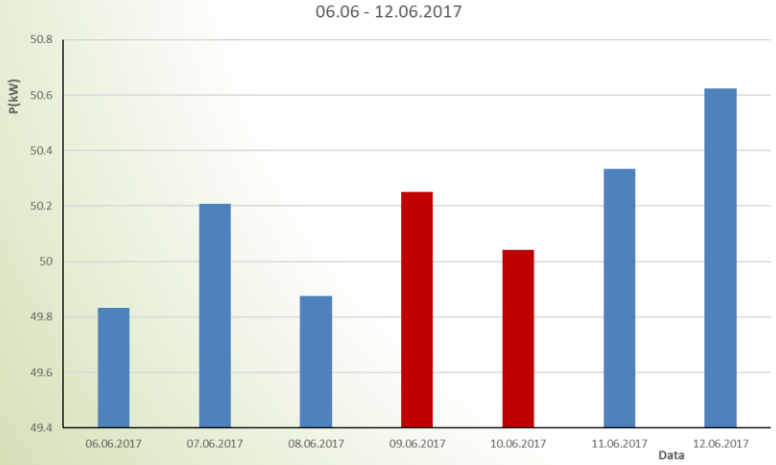


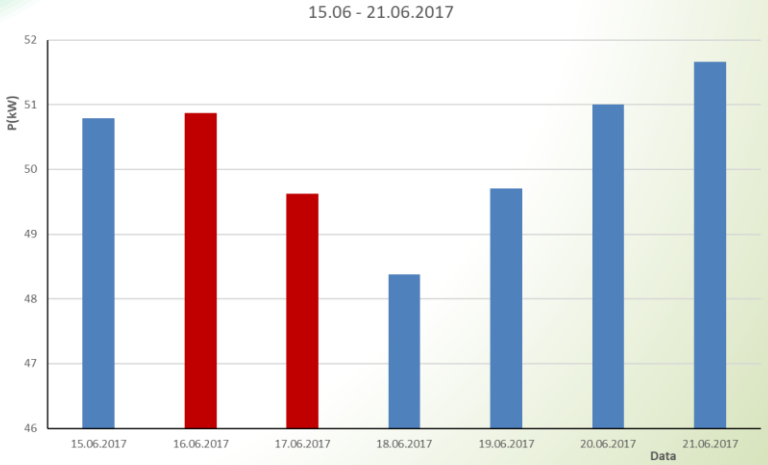
The power consumption in 16.12.2013 – 07.01.2014 period

Power consumption









Red color is for weekend time

Conclusions

❖ It was built an additional monitoring device that allows to register the temperature in various points and create a precise map of hot and cold zone inside of Data Center.

❖ Active power monitoring (on all three phases) in the same moment allow us to prevent major imbalances in the power supply system, and prevent the overload of the UPS.

❖ Advantages of the precise temperature monitoring:

- Based on recorded data for long periods of time it can be made simulations of data center operation and prognosis of power consumption;
- Establishing arrangements for operation of the air conditioning system
- Provide important information that help us to set up the position of newly add computing equipment;
- Maintaining Datacenter environmental conditions in the range in which computing systems work best;
- Reducing energy consumption.

- Increased number of sensors had increased the accuracy of hot zone determination

- Implementing concrete measures has led to a better functioning of the computer systems and energy savings;

- Data related to computer work (in the past monitored by MyEGI)

http://grid-monitoring.cern.ch/myegi/sa/

and currently monitored by SAM site

http://argo.egi.eu/ar-site

http://wlcg-sam-atlas.cern.ch/templates/ember/#/plot?group=Tier2s&profile=ATLAS_CRITICAL&sites=RO-14-ITIM

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Some of the implemented measures:

- positioning the computing systems so that the temperature in the hot zones is kept in the required parameters.

- The precise direction of cold air from the AC units to the computing systems ensures a better air circulation within the Data Center

Benefits

✓ The developed equipment allows a better adaptation of the monitoring system to operating characteristics of INCDTIM Data Center.

✓ The monitoring system shows great flexibility in choosing the parameters to be followed

ACKNOWLEDGEMENTS

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Thank you for your attention !